

We claim:

1. A process for removing sulfur from a hydrocarbon comprising:
conveying a feed stream past a first side of a solid membrane, wherein
said feed stream comprises a feed liquid hydrocarbon and a feed sulfur species;
5 conveying a sweep stream past a second side of said solid membrane;
transporting said feed sulfur species from said feed stream through said
solid membrane in a permeate into said sweep stream, thereby converting said
sweep stream to a sulfur-enriched stream and said feed stream to a substantially
sulfur-free reject stream containing a primary hydrocarbon product.
- 10 2. The process of claim 1 wherein said sweep stream comprises a sweep
liquid hydrocarbon.
3. The process of claim 2 wherein said sweep liquid hydrocarbon is
selected from the group consisting of naphtha, diesel, cycle oil, and mixtures
thereof.
- 15 4. The process of claim 1 wherein said feed sulfur species is substantially
more membrane permeable than said feed liquid hydrocarbon.
5. The process of claim 1 wherein said sweep stream is substantially
smaller than said feed stream.
- 20 6. The process of claim 1 wherein the weight ratio of said sweep stream
to said feed stream is below about 0.2.
7. The process of claim 1 wherein said feed liquid hydrocarbon is a
conventional refinery hydrocarbon stream.
8. The process of claim 1 wherein said feed liquid hydrocarbon is selected
from the group consisting of naphtha, diesel, and mixtures thereof.
- 25 9. The process of claim 1 wherein said feed sulfur species is selected
from the group consisting of an organic sulfur compound, elemental sulfur,
hydrogen sulfide and combinations thereof.
- 30 10. The process of claim 9 wherein said organic sulfur compound is
selected from the group consisting of thiols, alkylated thiols, thiophenes,
alkylated thiophenes, benzothiophene, alkylated benzothiophenes,
dibenzothiophenes, alkylated dibenzothiophenes and mixtures thereof.
11. The process of claim 1 wherein said membrane is formed from a
compound selected from the group consisting of nitrogen compounds, nitrogen

oxide compounds, oxygen compounds, sulfur compounds, sulfur oxide compounds, and mixtures thereof.

12. The process of claim 1 wherein said membrane is more selective for said feed sulfur species than said feed liquid hydrocarbon.


5 13. The process of claim 1 wherein said membrane contains a facilitated transport liquid.

14. The process of claim 13 wherein said facilitated transport liquid is selected from the group consisting of amines, hydroxyamines, alcohols, and mixtures thereof.

10 15. The process of claim 1 wherein said sweep stream comprises a decoupling agent species.

16. The process of claim 15 wherein said decoupling agent species is selected from the group consisting of amines, hydroxyamines, alcohols, sulfur compounds, and mixtures thereof.

15 17. The process of claim 1 further comprising distilling said sulfur-enriched stream to separate said feed sulfur species from said sweep stream.

 18. The process of claim 17 further comprising recycling said sweep stream separated from said feed sulfur species to said second side of said solid membrane.

20 19. A process for removing sulfur from a hydrocarbon comprising:
conveying a feed stream past a first side of a solid membrane, wherein said feed stream comprises a feed liquid hydrocarbon and a feed sulfur species and wherein said solid membrane contains a facilitated transport liquid;

25 transporting said feed sulfur species from said first side into said solid membrane in a permeate;

complexing said feed sulfur species with said facilitated transport liquid to form a facilitated transport complex; and

30 transporting said facilitated transport complex through said solid membrane to a second side of said membrane, thereby converting said feed stream to a substantially sulfur-free reject stream.

20. The process of claim 19 wherein said facilitated transport liquid is selected from the group consisting of amines, hydroxyamines, alcohols, and mixtures thereof.

21. The process of claim 19 further comprising decoupling said at least one sulfur species and said facilitated transport liquid by contacting said facilitated transport complex with a decoupling agent species on said second side.

5 22. The process of claim 21 wherein said decoupling agent species is selected from the group consisting of amines, hydroxyamines, alcohols, sulfur compounds, and mixtures thereof.

Handwritten signature/initials

10 23. A process for removing sulfur from a hydrocarbon comprising:
conveying a feed stream past a first side of a solid membrane, wherein
said feed stream comprises a feed liquid hydrocarbon and a feed sulfur species;
conveying a sweep stream past a second side of said solid membrane,
wherein said sweep stream comprises a membrane impermeable second liquid
hydrocarbon;

15 transporting said feed sulfur species from said feed stream through said
solid membrane in a permeate to said sweep stream, thereby converting said
sweep stream to a sulfur-enriched stream and said feed stream to a substantially
sulfur-free reject stream containing a primary hydrocarbon product; and
separating said permeate from said sweep stream in said sulfur-enriched
stream.

20 24. The process of claim 23 further comprising hydrogenating said
permeate after separating said permeate from said sweep stream.

25. The process of claim 23 further comprising hydrogenating said sulfur-
enriched stream before separating said permeate from said sweep stream.

ADD
A7 /

DRAWING GLOSSARY; 990017 USA

- 10 membrane separation unit
- 12 feed inlet
- 14 reject outlet
- 16 sweep inlet
- 18 sulfur-enriched outlet
- 20 selective membrane
- 22 feed chamber
- 24 sweep chamber
- 26 distillation unit
- 28 hydrogenation unit
- 30 sulfur-enriched inlet
- 32 overhead outlet
- 34 bottom outlet
- 36 overhead inlet
- 38 hydrogen inlet
- 40 hydrogen sulfide outlet
- 42 water outlet
- 44 residual hydrocarbon outlet
- 46 sulfur-enriched line
- 48 sweep recycle line
- 50 overhead line
- 52 residual hydrocarbon line
- 54 intersection
- 56 hydrocarbon product line